Corn (maize) sheller made from a leaf shredder-wood chipper

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A modified Roto-Hoe Leaf Shredder-Wood Chipper was used to shell corn (maize). Corn shelling rate was ~24 pounds of corn-on-the-cob per minute with 0.1 to 0.3% cracked kernels (10.9 kg per minute). The modifications reduce kernel damage during shelling.

Figure 1 Roto-Hoe Leaf Shredder/Wood Chipper with ¾ hp, 1725 rpm electric motor.

The following modifications were made:

1. Clearance between the free-swinging hammers and concave bars was increased from the original ¼ inch clearance to 1 inch (2.54 cm) clearance by replacing the original hammers with shorter hammers.
2. Individual free-swinging hammers were bolted together to convert free swinging hammers into a rasp bar configuration.
3. Rubber tubes were inserted into the bolt as spacer between the hammers to soften the impact of the rasp bar on grain kernel

4. For ease of shelling in batch mode, a 1 ½ pound (0.68 kg) weight was added to the top door to keep the door closed during shelling; instead of holding the door closed by hand. The top door was lifted open to discharge cobs after 3-5 second of shelling.

Figure 2 View of hammer assembly through top discharge door.

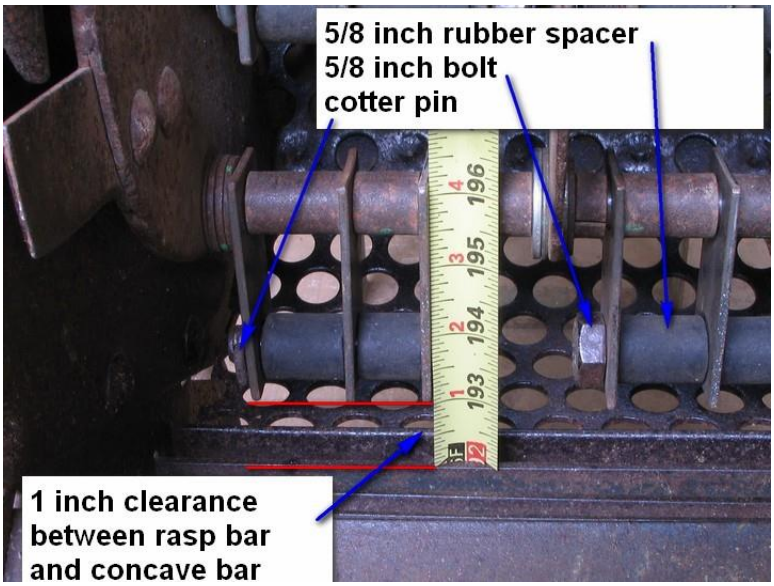

Figure 3 New hammers with 1 inch clearance between hammer and concave. Hammers are bolted together with 5/8-inch bolt to convert the free-swinging hammers into sets of rasp bars. The 5/8-inch spacers made from 5/8-inch garden hose were inserted between hammers to soften rasp bar impact on grain kernels.

Procedure:

1. Make 18 short hammers using 3/16-inch-thick x 1 ½ inch wide flat bar steel, cut to 3 ¼ inch length (4.7 x 38 x 82.5 mm) and drill 5/8-inch bolt holes

Figure 4 Top: original hammer (3/16 x 1 ½ x 4 inch) provided ¼ inch clearance (6.3 mm) between hammer and concave.
Middle: new hammer (3/16 x 1 ½ x 3 ¼ inch) provided 1 inch clearance (25.4 mm) between hammer and concave.
Bottom: 3/16 x 1 ½ inch steel flat bar used to make hammers.

2. Remove hammer assembly
    a. Remove front panel and 4 retaining bolts.

Figure 5 Front panel removed

b. Remove shaft bolt, and flange bearing nuts on the sheave side.

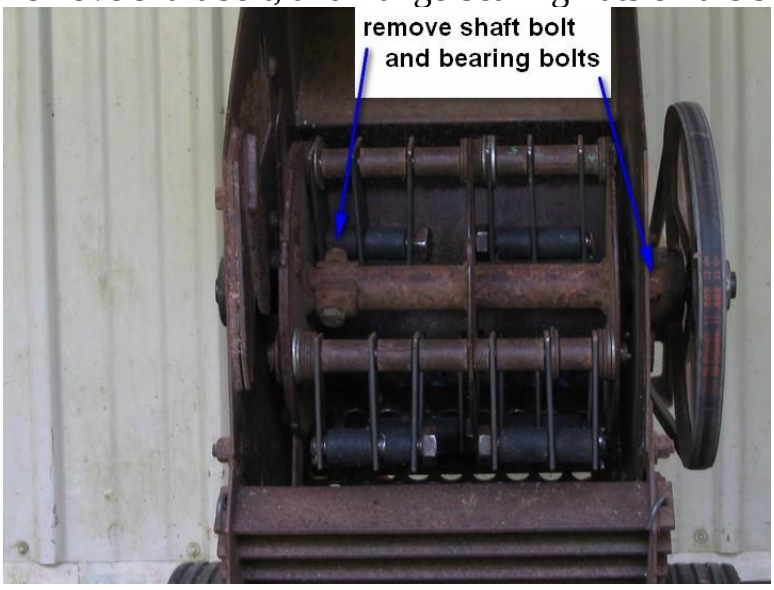

Figure 6 Location of shaft bolt and flange bearing nuts on the sheave side.

c. Slide shaft with sheave out and remove hammer assembly. Replace the original 4-inch hammers with shorter, 3 ¼ inch hammers. Drill hole in 5/8-inch bolt for locking bolt in place with cotter pin. Bolt the

hammers together with a 5/8-inch bolt. Use 5/8-inch garden hose or rubber tubing as spacer between each hammer.

Figure 7 remove shaft and hammer assembly

d. Reassemble in reverse order
e. Add 1 ½ pound (0.68 kg) weight to top door to keep the door closed during shelling; instead of holding the door close by hand.

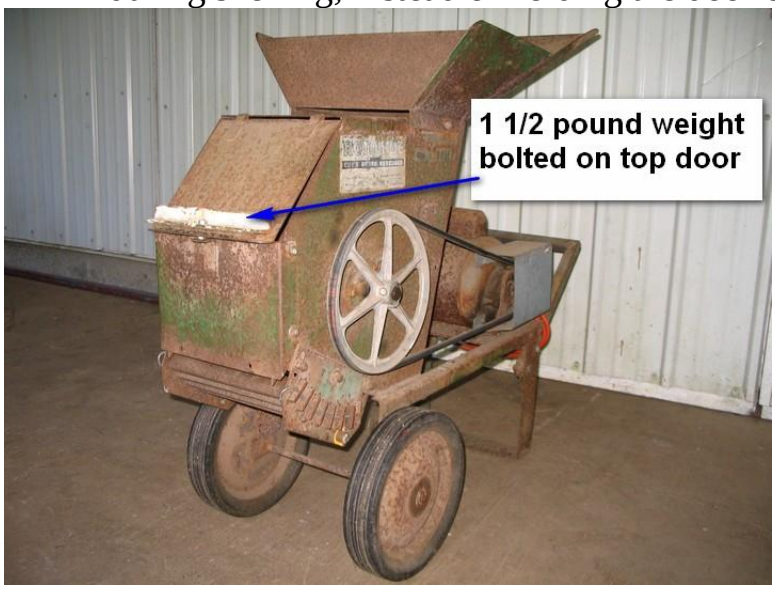

Figure 8 Location of 1 ½ pound weight added to top door.

Results:

The corn sheller was tested in 3 different hammer configurations using a Roto Hoe model 500 leaf shredder with a ¾ horsepower 1725 revolution per minute (rpm) electric motor, 2 ½ inch motor pulley, 10-inch sheave, and 430 rpm drum speed:

1. ¼ inch clearance free swinging hammers, i.e. no alteration to the original Roto Hoe Leaf Shredder;
2. ¼ inch clearance rasp bar, made by tying the free-swinging hammers together with bolt and rubber spacer inserted between the hammers;
3. 1 inch clearance between rasp bar and concave.

There were insufficient amount of corn-on-the-cobs to test the shelling performance of 1 inch clearance free swinging hammer.

Corn shelling was tested using small hard flint corn, Pink Pearl popcorn (0.134 gram/kernel) and large soft flour corn, Red Mandan parching corn (0.274 gram/kernel).

Corn shelling rate was ~24 pounds of corn-on-the-cob per minute (10.9 kg per minute) for both flour corn and popcorn; cobs were ~ 18% of the corn-on-the-cob weight.

After shelling, the number of cracked corn chips in 1 cup samples (0.236 liter) were counted and weighed

Test configuration	Number of cracked chips, standard deviation, number of samples	% crack by weight
Parching corn, ¼ inch clearance, free swinging hammer	28; +/- 5.5; n=5	2%; +/- 0.4%
Parching corn ¼ inch clearance rasp bar	30; +/- 4.6; n=8	2%; +/- 0.3%
Parching corn, 1 inch clearance, rasp bar	4; +/- 2.6; n=13	0.3%; +/- 0.2%
Popcorn, ¼ inch clearance, free swinging hammers	2.1; +/- 1.0; n=10	0.2%; +/- 0.1%
Popcorn, ¼ inch clearance, rasp bar	2.8; +/- 2.4; n=10	0.2%; +/- 0.2%
Popcorn, 1 inch clearance, rasp bar	0.8; +/- 0.7; n=10	0.1%; +/- 0.1%

Discussion:

For soft flour corn, increasing rasp bar clearance from ¼ inch to 1 inch (from 6.3 to 25.4 mm) decreased the percent of cracked corn chips from 2% to 0.3% by weight. The reduction in cracked kernels was attributed to greater clearance and lower kinetic energy of impact using shorter hammers. The radius from center to tip of the shorter hammer is 0.889 x radius of the long hammer; with a corresponding 0.889 x tangential velocity of the long hammer. Kinetic energy is proportional to velocity squared (K.E. = ½ mv^2); a 0.889 x velocity corresponds to a 21% reduction in kinetic energy impact using the shorter hammer.

There was no measurable difference in percent of cracked flour corn kernels by weight, between free swinging hammer and a rasp bar at ¼ inch clearance.

For popcorn, there was not enough data to statistically resolve the differences between ¼ inch clearance and 1 inch clearance rasp bar. The 1-inch clearance yielded 0.1 crack by weight while the ¼-inch clearance yielded 0.2% crack by weight; but with overlapping standard deviations. This was attributed to smaller, harder popcorn kernels compared to the softer, larger flour kernels.

The percent damaged kernel was measured by collecting the cracked kernels. This does not account for kernels that were completely pulverized into dust and lost during seed cleaning prior to measurements.

These results were from a Roto Hoe model 500 leaf shredder with a ¾ horsepower 1725 rpm electric motor and 430 rpm drum speed, instead of the original 2800 rpm gas engine. Higher engine rpm will yield higher amount of kernel damage.

Acknowledgements:

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